

## Description

The 9FGV0441 is an 4-output very low power clock generator for PCIe Gen 1, 2, 3 and 4 applications with integrated output terminations providing  $Z_o = 100\Omega$ . The device has 4 output enables for clock management and supports 2 different spread spectrum levels in addition to spread off.

## Recommended Application

PCIe Gen1–4 clock generation for Riser Cards, Storage, Networking, JBOD, Communications, Access Points

## Output Features

- 4 0.7V low-power HCSL-compatible (LP-HCSL) DIF pairs with  $Z_o=100\Omega$
- 1 1.8V LVCMS REF output with Wake-On-Lan (WOL) support

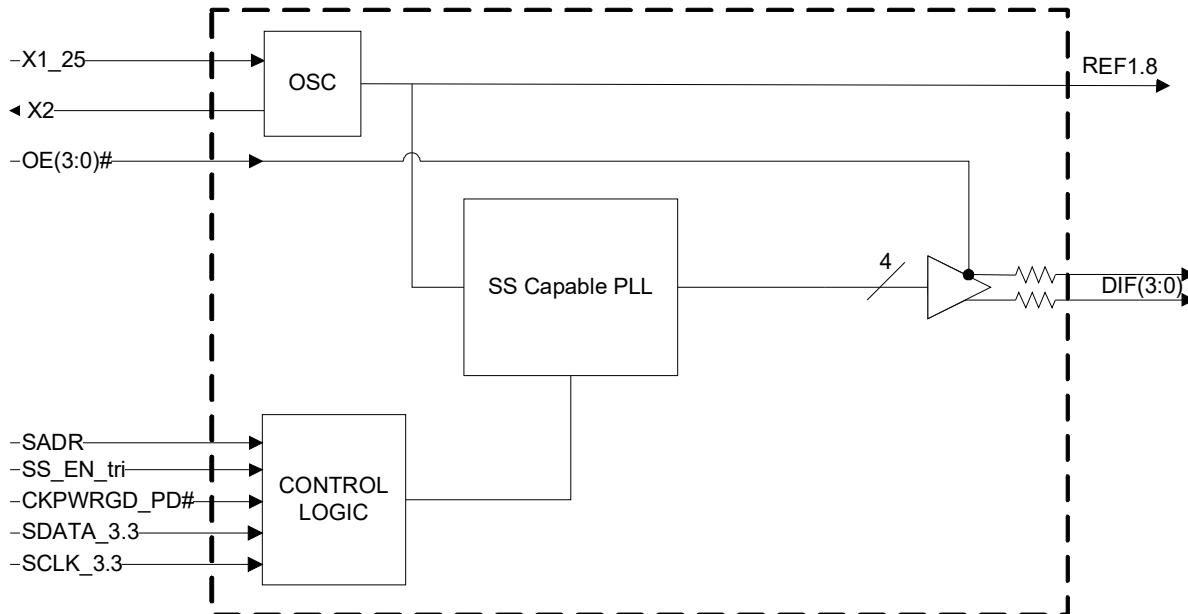
## Key Specifications

- DIF cycle-to-cycle jitter < 50ps
- DIF output-to-output skew < 50ps
- DIF phase jitter is PCIe Gen1–4 compliant
- REF phase jitter is < 1.5ps RMS

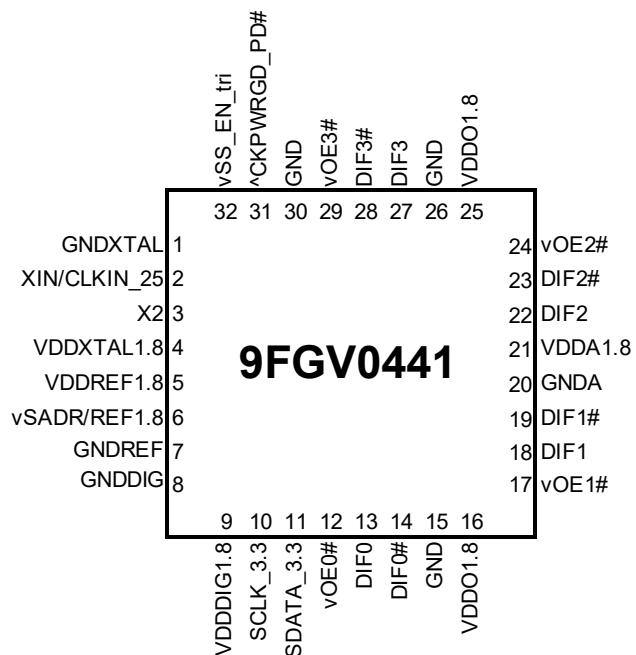
## Features/Benefits

- Integrated terminations provide  $100\Omega$  differential  $Z_o$ ; reduced component count and board space
- 1.8V operation; reduced power consumption
- OE# pins; support DIF power management
- LP-HCSL differential clock outputs; reduced power and board space
- Programmable slew rate for each output; allows tuning for various line lengths
- Programmable output amplitude; allows tuning for various application environments
- DIF outputs blocked until PLL is locked; clean system start-up
- Selectable 0%, -0.25% or -0.5% spread on DIF outputs; reduces EMI
- External 25MHz crystal; supports tight ppm with 0 ppm synthesis error
- Configuration can be accomplished with strapping pins; SMBus interface not required for device control
- 3.3V tolerant SMBus interface works with legacy controllers
- Space saving 5 x 5 mm 32-VFQFPN; minimal board space
- Selectable SMBus addresses; multiple devices can easily share an SMBus segment

## Block Diagram



## Pin Configuration



**32-VFQFPN, 5 x 5 mm, 0.5mm pitch**

^ prefix indicates internal 120kOhm pull-up resistor  
v prefix indicates internal 120kOhm pull down-resistor

## SMBus Address Selection Table

	SADR	Address	+	Read/Write Bit
State of SADR on first application of CKPWRGD_PD#	0	1101000		x
	1	1101010		x

## Power Management Table

CKPWRGD_PD#	SMBus OE bit	DIFx			REF
		OEx#	True O/P	Comp. O/P	
0	X	X	Low	Low	Hi-Z <sup>1</sup>
1	1	0	Running	Running	Running
1	0	1	Low	Low	Low

1. REF is Hi-Z until the 1st assertion of CKPWRGD\_PD# high. After this, when CKPWRG\_PD# is low, REF is Low.

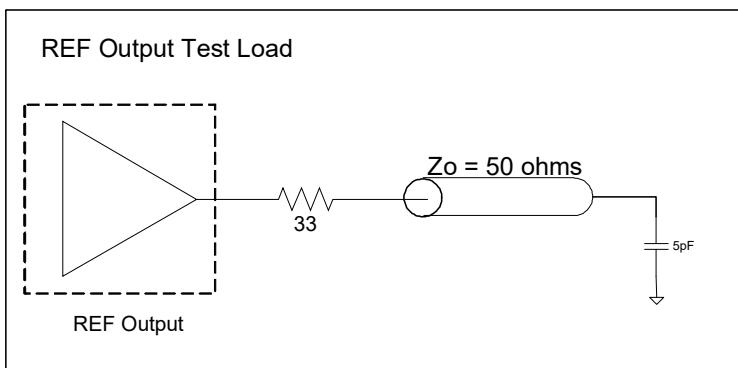
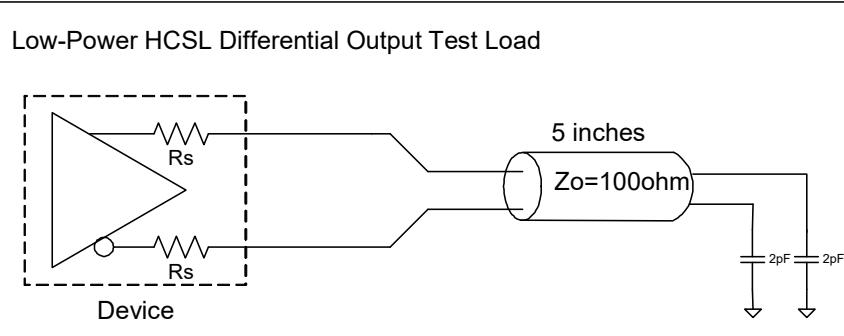
## Power Connections

Pin Number		Description
VDD	GND	
4	1	XTAL Analog
5	7	REF Output
9	8, 30	Digital Power
16, 25	15, 26	DIF outputs
21	20	PLL Analog

## Pin Descriptions

Pin#	Pin Name	Type	Pin Description
1	GNDXTAL	GND	GND for XTAL
2	XIN/CLKIN_25	IN	Crystal input or Reference Clock input. Nominally 25MHz.
3	X2	OUT	Crystal output.
4	VDDXTAL1.8	PWR	Power supply for XTAL, nominal 1.8V
5	VDDREF1.8	PWR	VDD for REF output. nominal 1.8V.
6	vSADR/REF1.8	LATCHED I/O	Latch to select SMBus Address/1.8V LVC MOS copy of X1 pin.
7	GNDREF	GND	Ground pin for the REF outputs.
8	GNDDIG	GND	Ground pin for digital circuitry
9	VDDDIG1.8	PWR	1.8V digital power (dirty power)
10	SCLK_3.3	IN	Clock pin of SMBus circuitry, 3.3V tolerant.
11	SDATA_3.3	I/O	Data pin for SMBus circuitry, 3.3V tolerant.
12	vOE0#	IN	Active low input for enabling DIF pair 0. This pin has an internal pull-down. 1 = disable outputs, 0 = enable outputs
13	DIF0	OUT	Differential true clock output
14	DIF0#	OUT	Differential Complementary clock output
15	GND	GND	Ground pin.
16	VDDO1.8	PWR	Power supply for outputs, nominally 1.8V.
17	vOE1#	IN	Active low input for enabling DIF pair 1. This pin has an internal pull-down. 1 = disable outputs, 0 = enable outputs
18	DIF1	OUT	Differential true clock output
19	DIF1#	OUT	Differential Complementary clock output
20	GNDA	GND	Ground pin for the PLL core.
21	VDDA1.8	PWR	1.8V power for the PLL core.
22	DIF2	OUT	Differential true clock output
23	DIF2#	OUT	Differential Complementary clock output
24	vOE2#	IN	Active low input for enabling DIF pair 2. This pin has an internal pull-down. 1 = disable outputs, 0 = enable outputs
25	VDDO1.8	PWR	Power supply for outputs, nominally 1.8V.
26	GND	GND	Ground pin.
27	DIF3	OUT	Differential true clock output
28	DIF3#	OUT	Differential Complementary clock output
29	vOE3#	IN	Active low input for enabling DIF pair 3. This pin has an internal pull-down. 1 = disable outputs, 0 = enable outputs
30	GND	GND	Ground pin.
31	^CKPWRGD_PD#	IN	Input notifies device to sample latched inputs and start up on first high assertion. Low enters Power Down Mode, subsequent high assertions exit Power Down Mode. This pin has internal pull-up resistor.
32	vSS_EN_tri	LATCHED IN	Latched select input to select spread spectrum amount at initial power up : 1 = -0.5% spread, M = -0.25%, 0 = Spread Off

## Test Loads



## Alternate Terminations

The output can easily drive other logic families. See “[AN-891 Driving LVPECL, LVDS, CML, and SSTL Logic with Universal Low-Power HCSL Outputs](#)” for LVPECL, LVDS, CML, and SSTL.

## Absolute Maximum Ratings

Stresses above the ratings listed below can cause permanent damage to the 9FGV0441. These ratings, which are standard values for Renesas commercially rated parts, are stress ratings only. Functional operation of the device at these or any other conditions above those indicated in the operational sections of the specifications is not implied. Exposure to absolute maximum rating conditions for extended periods can affect product reliability. Electrical parameters are guaranteed only over the recommended operating temperature range.

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS	NOTES
1.8V Supply Voltage	VDDx1.8	Applies to All VDD pins	-0.5		2.5	V	1,2
Input Voltage	V <sub>IN</sub>		-0.5		V <sub>DD</sub> +0.3V	V	1, 3
Input High Voltage, SMBus	V <sub>IHSMB</sub>	SMBus clock and data pins			3.6V	V	1
Storage Temperature	T <sub>S</sub>		-65		150	°C	1
Junction Temperature	T <sub>j</sub>				125	°C	1
Input ESD protection	ESD prot	Human Body Model	2000			V	1

<sup>1</sup>Guaranteed by design and characterization, not 100% tested in production.

<sup>2</sup>Operation under these conditions is neither implied nor guaranteed.

<sup>3</sup>Not to exceed 2.5V.

## Electrical Characteristics—Current Consumption

TA = T<sub>COM</sub> or T<sub>IND</sub>; Supply Voltage per VDD of normal operation conditions, See Test Loads for Loading Conditions

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS	NOTES
Operating Supply Current	I <sub>DDAOP</sub>	VDDA, All outputs active @100MHz		6	8	mA	1
	I <sub>DDOP</sub>	VDD, All outputs active @100MHz		26	30	mA	1
Suspend Supply Current	I <sub>DDSUSP</sub>	VDDxxx, PD#=0, Wake-On-LAN enabled		6	8	mA	1
Powerdown Current	I <sub>DDPD</sub>	PD#=0		0.6	1	mA	1, 2

<sup>1</sup>Guaranteed by design and characterization, not 100% tested in production.

<sup>2</sup>Assuming REF is not running in power down state

## Electrical Characteristics—Output Duty Cycle, Jitter, and Skew Characteristics

TA = T<sub>COM</sub> or T<sub>IND</sub>; Supply Voltage per VDD of normal operation conditions, See Test Loads for Loading Conditions

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS	NOTES
Duty Cycle	t <sub>DC</sub>	Measured differentially, PLL Mode	45	50	55	%	1
Skew, Output to Output	t <sub>sk3</sub>	V <sub>T</sub> = 50%		34	50	ps	1
Jitter, Cycle to cycle	t <sub>jyc-cyc</sub>	PLL mode		14	50	ps	1,2

<sup>1</sup>Guaranteed by design and characterization, not 100% tested in production.

<sup>2</sup>Measured from differential waveform

## Electrical Characteristics–Input/Supply/Common Parameters–Normal Operating Conditions

TA =  $T_{COM}$  or  $T_{IND}$ ; Supply Voltage per VDD of normal operation conditions, See Test Loads for Loading Conditions

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS	NOTES
1.8V Supply Voltage	$V_{DD_{X1.8}}$	Supply voltage for core, analog and single-ended LVCMOS outputs	1.7	1.8	1.9	V	1
Ambient Operating Temperature	$T_{IND}$	Industrial range	-40	25	85	°C	1
Input High Voltage	$V_{IH}$	Single-ended inputs, except SMBus	$0.75 V_{DD}$		$V_{DD} + 0.3$	V	1
Input Mid Voltage	$V_{IM}$	Single-ended tri-level inputs ('_tri' suffix, if present)	$0.4 V_{DD}$		$0.6 V_{DD}$	V	1
Input Low Voltage	$V_{IL}$	Single-ended inputs, except SMBus	-0.3		$0.25 V_{DD}$	V	1
Schmitt Trigger Positive Going Threshold Voltage	$V_{T+}$	Single-ended inputs, where indicated	$0.4 V_{DD}$		$0.7 V_{DD}$	V	1
Schmitt Trigger Negative Going Threshold Voltage	$V_{T-}$	Single-ended inputs, where indicated	$0.1 V_{DD}$		$0.4 V_{DD}$	V	1
Hysteresis Voltage	$V_H$	$V_{T+} - V_{T-}$	$0.1 V_{DD}$		$0.4 V_{DD}$	V	1
Output High Voltage	$V_{IH}$	Single-ended outputs, except SMBus. $I_{OH} = -2mA$	$V_{DD} - 0.45$			V	1
Output Low Voltage	$V_{IL}$	Single-ended outputs, except SMBus. $I_{OL} = -2mA$			0.45	V	1
Input Current	$I_{IN}$	Single-ended inputs, $V_{IN} = GND$ , $V_{IN} = VDD$	-5		5	uA	1
	$I_{INP}$	Single-ended inputs $V_{IN} = 0 V$ ; Inputs with internal pull-up resistors $V_{IN} = VDD$ ; Inputs with internal pull-down resistors	-20		20	uA	1
Input Frequency	$f_{in}$	XTAL, or X1 input	23	25	27	MHz	1
Pin Inductance	$L_{pin}$				7	nH	1
Capacitance	$C_{IN}$	Logic Inputs, except DIF_IN	1.5		5	pF	1
	$C_{OUT}$	Output pin capacitance			6	pF	1
Clk Stabilization	$T_{STAB}$	From $V_{DD}$ Power-Up and after input clock stabilization or de-assertion of PD# to 1st clock		0.6	1.8	ms	1,2
SS Modulation Frequency	$f_{MOD}$	Allowable Frequency (Triangular Modulation)	31	31.6	32	kHz	1
OE# Latency	$t_{LATOE\#}$	DIF start after OE# assertion DIF stop after OE# deassertion	2	3	4	clocks	1,3
Tdrive_PD#	$t_{DRVPD}$	DIF output enable after PD# de-assertion		4	300	us	1,3
Tfall	$t_f$	Fall time of single-ended control inputs			5	ns	1,2
Trise	$t_r$	Rise time of single-ended control inputs			5	ns	1,2
SMBus Input Low Voltage	$V_{ILSMB}$	$V_{DDSMB} = 3.3V$ , see note 4 for $V_{DDSMB} < 3.3V$			0.8	V	1,4
SMBus Input High Voltage	$V_{IHSM}$	$V_{DDSMB} = 3.3V$ , see note 5 for $V_{DDSMB} < 3.3V$	2.1		3.6	V	1,5
SMBus Output Low Voltage	$V_{OLSMB}$	@ $I_{PULLUP}$			0.4	V	1
SMBus Sink Current	$I_{PULLUP}$	@ $V_{OL}$	4			mA	1
Nominal Bus Voltage	$V_{DDSMB}$		1.7		3.6	V	1
SCLK/SDATA Rise Time	$t_{RSMB}$	(Max $V_{IL} - 0.15$ ) to (Min $V_{IH} + 0.15$ )			1000	ns	1
SCLK/SDATA Fall Time	$t_{FSMB}$	(Min $V_{IH} + 0.15$ ) to (Max $V_{IL} - 0.15$ )			300	ns	1
SMBus Operating Frequency	$f_{MAXSMB}$	Maximum SMBus operating frequency			400	kHz	1

<sup>1</sup> Guaranteed by design and characterization, not 100% tested in production.

<sup>2</sup> Control input must be monotonic from 20% to 80% of input swing.

<sup>3</sup> Time from deassertion until outputs are > 200mV.

<sup>4</sup> For  $V_{DDSMB} < 3.3V$ ,  $V_{ILSMB} \leq 0.35V_{DDSMB}$ .

<sup>5</sup> For  $V_{DDSMB} < 3.3V$ ,  $V_{IHSM} \geq 0.65V_{DDSMB}$ .

## Electrical Characteristics—DIF 0.7V Low Power HCSL Outputs

$T_A = T_{COM}$  or  $T_{IND}$ ; supply voltage per VDD of normal operation conditions; see Test Loads for loading conditions.

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS	NOTES
Slew Rate	Trf	Scope averaging on 3.0V/ns setting.	2.3	3.1	4	V/ns	1, 2, 3
		Scope averaging on 2.0V/ns setting.	1.6	2.3	3.3	V/ns	1, 2, 3
Slew Rate Matching	$\Delta$ Trf	Single-ended measurement.		3	20	%	1, 4
Voltage High	$V_{HIGH}$	Statistical measurement on single-ended signal using oscilloscope math function (scope averaging on).	660	794	850	mV	1, 7
Voltage Low	$V_{LOW}$		-150	21	150		1
Max Voltage	$V_{max}$	Measurement on single-ended signal using absolute value (scope averaging off).		816	1150	mV	1
Min Voltage	$V_{min}$		-300	-15			1
$V_{swing}$	$V_{swing}$	Scope averaging off.	300	1551		mV	1, 2
Crossing Voltage (abs)	$V_{cross\_abs}$	Scope averaging off.	300	397	550	mV	1, 5
Crossing Voltage (var)	$\Delta V_{cross}$	Scope averaging off.		15	140	mV	1, 6

<sup>1</sup>Guaranteed by design and characterization, not 100% tested in production.

<sup>2</sup> Measured from differential waveform.

<sup>3</sup> Slew rate is measured through the  $V_{swing}$  voltage range centered around differential 0V. This results in a +/-150mV window around differential 0V.

<sup>4</sup> Matching applies to rising edge rate for Clock and falling edge rate for Clock#. It is measured using a +/-75mV window centered on the average cross point where Clock rising meets Clock# falling. The median cross point is used to calculate the voltage thresholds the oscilloscope is to use for the edge rate calculations.

<sup>5</sup>  $V_{cross}$  is defined as voltage where Clock = Clock# measured on a component test board and only applies to the differential rising edge (i.e. Clock rising and Clock# falling).

<sup>6</sup> The total variation of all  $V_{cross}$  measurements in any particular system. Note that this is a subset of  $V_{cross\_min/max}$  ( $V_{cross}$  absolute) allowed. The intent is to limit  $V_{cross}$  induced modulation by setting  $\Delta V_{cross}$  to be smaller than  $V_{cross}$  absolute.

<sup>7</sup> At default SMBus settings.

## Electrical Characteristics—Filtered Phase Jitter Parameters - PCIe Common Clocked (CC) Architectures

$T_{AMB}$  = over the specified operating range. Supply Voltages per normal operation conditions, See Test Loads for Loading Conditions

SYMBOL	PARAMETER	CONDITIONS	MIN	TYP	MAX	Specification Limit	UNITS	NOTES
$t_{jphPClēG1-CC}$	Phase Jitter, PLL Mode	PCIe Gen 1	21	25	35	86	ps (p-p)	1, 2, 3
$t_{jphPClēG2-CC}$		PCIe Gen 2 Low Band 10kHz < f < 1.5MHz (PLL BW of 5-16MHz, 8-16MHz, CDR = 5MHz)	0.9	0.9	1.1	3	ps (rms)	1, 2
$t_{jphPClēG3-CC}$		PCIe Gen 2 High Band 1.5MHz < f < Nyquist (50MHz) (PLL BW of 5-16MHz, 8-16MHz, CDR = 5MHz)	1.5	1.6	1.9	3.1	ps (rms)	1, 2
$t_{jphPClēG4-CC}$		PCIe Gen 3 (PLL BW of 2-4MHz, 2-5MHz, CDR = 10MHz)	0.3	0.37	0.44	1	ps (rms)	1, 2
		PCIe Gen 4 (PLL BW of 2-4MHz, 2-5MHz, CDR = 10MHz)	0.3	0.37	0.44	0.5	ps (rms)	1, 2

### Notes on PCIe Filtered Phase Jitter Table

<sup>1</sup> Applies to all differential outputs, guaranteed by design and characterization.

<sup>2</sup> Calculated from Intel-supplied Clock Jitter Tool, with spread on and off.

<sup>3</sup> Sample size of at least 100K cycles. This figure extrapolates to 108ps pk-pk at 1M cycles for a BER of  $1^{-12}$ .

## Electrical Characteristics–REF

TA =  $T_{COM}$  or  $T_{IND}$ ; Supply Voltage per VDD of normal operation conditions, See Test Loads for Loading Conditions

PARAMETER	SYMBOL	CONDITIONS	MIN	TYP	MAX	UNITS	Notes
Long Accuracy	ppm	see $T_{period}$ min-max values	0			ppm	1,2
Clock period	$T_{period}$	25 MHz output nominal		40		ns	1,2
Rise/Fall Slew Rate	$t_{rf1}$	Byte 3 = 1F, $V_{OH} = VDD-0.45V$ , $V_{OL} = 0.45V$	0.6	1	1.8	V/ns	1,3
Rise/Fall Slew Rate	$t_{rf1}$	Byte 3 = 5F, $V_{OH} = VDD-0.45V$ , $V_{OL} = 0.45V$	1.0	1.6	2.5	V/ns	1,3
Rise/Fall Slew Rate	$t_{rf1}$	Byte 3 = 9F, $V_{OH} = VDD-0.45V$ , $V_{OL} = 0.45V$	1.3	2	3.0	V/ns	1,3
Rise/Fall Slew Rate	$t_{rf1}$	Byte 3 = DF, $V_{OH} = VDD-0.45V$ , $V_{OL} = 0.45V$	1.4	2.1	3.1	V/ns	1,3
Duty Cycle	$d_{r1}$	$V_T = VDD/2$ V	45	53.2	55	%	1,4
Duty Cycle Distortion	$d_{tcd}$	$V_T = VDD/2$ V	0	2	4	%	1,5
Jitter, cycle to cycle	$t_{j_{cyc-cyc}}$	$V_T = VDD/2$ V		0	75	ps	1,4
Noise floor	$t_{j_{dBc1k}}$	1kHz offset		-130	-105	dBc	1,4
Noise floor	$t_{j_{dBc10k}}$	10kHz offset to Nyquist		-140	-120	dBc	1,4
Jitter, phase	$t_{j_{phREF}}$	12kHz to 5MHz		0.68	1.5	ps (rms)	1,4

<sup>1</sup>Guaranteed by design and characterization, not 100% tested in production.

<sup>2</sup>All Long Term Accuracy and Clock Period specifications are guaranteed assuming that REF is trimmed to 25.00 MHz

<sup>3</sup>Typical value occurs when REF slew rate is set to default value

<sup>4</sup>When driven by a crystal.

<sup>5</sup>When driven by an external oscillator via the X1 pin. X2 should be floating in this case.

## Clock Periods–Differential Outputs with Spread Spectrum Disabled

SSC OFF	Center Freq. MHz	Measurement Window							Units	Notes
		1 Clock	1us	0.1s	0.1s	0.1s	1us	1 Clock		
		-c2c jitter AbsPer Min	-SSC Short-Term Average Min	- ppm Long-Term Average Min	0 ppm Period Nominal	+ ppm Long-Term Average Max	+SSC Short-Term Average Max	+c2c jitter AbsPer Max		
DIF	100.00	9.94900		9.99900	10.00000	10.00100		10.05100	ns	1,2

## Clock Periods–Differential Outputs with -0.5% Spread Spectrum Enabled

SSC ON	Center Freq. MHz	Measurement Window							Units	Notes
		1 Clock	1us	0.1s	0.1s	0.1s	1us	1 Clock		
		-c2c jitter AbsPer Min	-SSC Short-Term Average Min	- ppm Long-Term Average Min	0 ppm Period Nominal	+ ppm Long-Term Average Max	+SSC Short-Term Average Max	+c2c jitter AbsPer Max		
DIF	99.75	9.94906	9.99906	10.02406	10.02506	10.02607	10.05107	10.10107	ns	1,2

<sup>1</sup>Guaranteed by design and characterization, not 100% tested in production.

<sup>2</sup>All Long Term Accuracy and Clock Period specifications are guaranteed assuming that REF is trimmed to 25.00 MHz

## General SMBus Serial Interface Information

## How to Write

- Controller (host) sends a start bit
- Controller (host) sends the write address
- Renesas clock will **acknowledge**
- Controller (host) sends the beginning byte location = N
- Renesas clock will **acknowledge**
- Controller (host) sends the byte count = X
- Renesas clock will **acknowledge**
- Controller (host) starts sending Byte **N** through Byte **N+X-1**
- Renesas clock will **acknowledge** each byte **one at a time**
- Controller (host) sends a Stop bit

## How to Read

- Controller (host) will send a start bit
- Controller (host) sends the write address
- Renesas clock will **acknowledge**
- Controller (host) sends the beginning byte location = N
- Renesas clock will **acknowledge**
- Controller (host) will send a separate start bit
- Controller (host) sends the read address
- Renesas clock will **acknowledge**
- Renesas clock will send the data byte count = X
- Renesas clock sends Byte 0 through Byte X (if  $X_{(H)}$  was written to Byte 8)
- Controller (host) will need to acknowledge each byte
- Controller (host) will send a not acknowledge bit
- Controller (host) will send a stop bit

Index Block Write Operation	
<b>Controller (Host)</b>	<b>Renesas (Slave/Receiver)</b>
T	starT bit
Slave Address	
WR	WRite
Beginning Byte = N	ACK
Data Byte Count = X	ACK
Beginning Byte N	ACK
O	X Byte
O	
O	
Byte N + X - 1	ACK
P	stoP bit

Note: Read/Write address is latched on SADR pin.

Index Block Read Operation		
<b>Controller (Host)</b>		<b>Renesas</b>
T	starT bit	
	Slave Address	
WR	WRite	
		ACK
	Beginning Byte = N	
		ACK
RT	Repeat starT	
	Slave Address	
RD	ReaD	
		ACK
		Data Byte Count=X
ACK		
		Beginning Byte N
ACK		
		O
O		O
O		O
O		
		Byte N + X - 1
N	Not acknowledge	
P	stop bit	

**SMBus Table: Output Enable Register**

Byte 0	Name	Control Function	Type	0	1	Default
Bit 7		Reserved				1
Bit 6		Reserved				1
Bit 5		Reserved				1
Bit 4		Reserved				1
Bit 3	DIF OE3	Output Enable	RW	Low/Low	Enabled	1
Bit 2	DIF OE3	Output Enable	RW	Low/Low	Enabled	1
Bit 1	DIF OE2	Output Enable	RW	Low/Low	Enabled	1
Bit 0	DIF OE1	Output Enable	RW	Low/Low	Enabled	1

**SMBus Table: SS Readback and Vhigh Control Register**

Byte 1	Name	Control Function	Type	0	1	Default
Bit 7	SSENRB1	SS Enable Readback Bit1	R	00' for SS_EN_tri = 0, '01' for SS_EN_tri = 'M', '11' for SS_EN_tri = '1'		Latch
Bit 6	SSENRB1	SS Enable Readback Bit0	R			Latch
Bit 5	SSEN_SWCNTRL	Enable SW control of SS	RW	SS control locked	Values in B1[4:3] control SS amount.	0
Bit 4	SSENSW1	SS Enable Software Ctrl Bit1	RW <sup>1</sup>	00' = SS Off, '01' = -0.25% SS,		0
Bit 3	SSENSW0	SS Enable Software Ctrl Bit0	RW <sup>1</sup>	'10' = Reserved, '11' = -0.5% SS		0
Bit 2		Reserved				1
Bit 1	AMPLITUDE 1	Controls Output Amplitude	RW	00 = 0.6V	01 = 0.7V	1
Bit 0	AMPLITUDE 0		RW	10 = 0.8V	11 = 0.9V	0

1. B1[5] must be set to a 1 for these bits to have any effect on the part.

**SMBus Table: DIF Slew Rate Control Register**

Byte 2	Name	Control Function	Type	0	1	Default
Bit 7		Reserved				1
Bit 6		Reserved				1
Bit 5		Reserved				1
Bit 4		Reserved				1
Bit 3	SLEWRATESEL DIF3	Adjust Slew Rate of DIF3	RW	2.0V/ns	3.0V/ns	1
Bit 2	SLEWRATESEL DIF2	Adjust Slew Rate of DIF2	RW	2.0V/ns	3.0V/ns	1
Bit 1	SLEWRATESEL DIF1	Adjust Slew Rate of DIF3	RW	2.0V/ns	3.0V/ns	1
Bit 0	SLEWRATESEL DIF0	Adjust Slew Rate of DIF1	RW	2.0V/ns	3.0V/ns	1

**SMBus Table: REF Control Register**

Byte 3	Name	Control Function	Type	0	1	Default
Bit 7	REF	Slew Rate Control	RW	00 = Slowest	01 = Slow	0
			RW	10 = Fast	11 = Faster	1
Bit 5	REF Power Down Function	Wake-on-Lan Enable for REF	RW	REF does not run in Power Down	REF runs in Power Down	0
Bit 4	REF OE	REF Output Enable	RW	Low	Enabled	1
Bit 3		Reserved				1
Bit 2		Reserved				1
Bit 1		Reserved				1
Bit 0		Reserved				1

Byte 4 is reserved and reads back 'hFF'.

**SMBus Table: Revision and Vendor ID Register**

Byte 5	Name	Control Function	Type	0	1	Default
Bit 7	RID3	Revision ID	R	A rev = 0000		0
Bit 6	RID2		R			0
Bit 5	RID1		R			0
Bit 4	RID0		R			0
Bit 3	VID3	VENDOR ID	R	0001 = IDT		0
Bit 2	VID2		R			0
Bit 1	VID1		R			0
Bit 0	VID0		R			1

**SMBus Table: Device Type/Device ID**

Byte 6	Name	Control Function	Type	0	1	Default
Bit 7	Device Type1	Device Type	R	00 = FGV, 01 = DBV, 10 = DMV, 11= Reserved		0
Bit 6	Device Type0		R			0
Bit 5	Device ID5	Device ID	R	000100 binary or 04 hex		0
Bit 4	Device ID4		R			0
Bit 3	Device ID3	Device ID	R	000100 binary or 04 hex		0
Bit 2	Device ID2		R			1
Bit 1	Device ID1	Device ID	R	000100 binary or 04 hex		0
Bit 0	Device ID0		R			0

**SMBus Table: Byte Count Register**

Byte 7	Name	Control Function	Type	0	1	Default
Bit 7		Reserved				0
Bit 6		Reserved				0
Bit 5		Reserved				0
Bit 4	BC4	Byte Count Programming	RW	Writing to this register will configure how many bytes will be read back, default is = 8 bytes.		
Bit 3	BC3		RW	1		
Bit 2	BC2		RW	0		
Bit 1	BC1		RW	0		
Bit 0	BC0		RW	0		

## Recommended Crystal Characteristics (3225 package)

PARAMETER	VALUE	UNITS	NOTES
Frequency	25	MHz	1
Resonance Mode	Fundamental	-	1
Frequency Tolerance @ 25°C	±20	PPM Max	1
Frequency Stability, ref @ 25°C Over Operating Temperature Range	±20	PPM Max	1
Temperature Range (commercial)	0~70	°C	1
Temperature Range (industrial)	-40~85	°C	2
Equivalent Series Resistance (ESR)	50	Ω Max	1
Shunt Capacitance (C <sub>0</sub> )	7	pF Max	1
Load Capacitance (C <sub>L</sub> )	8	pF Max	1
Drive Level	0.3	mW Max	1
Aging per year	±5	PPM Max	1

### Notes:

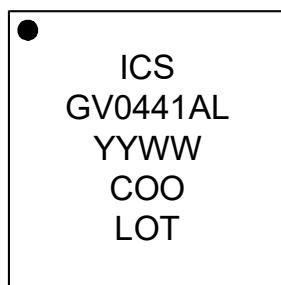
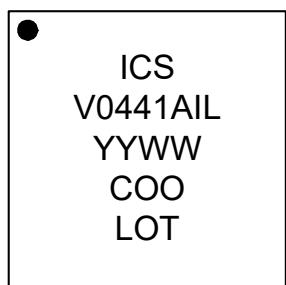
1. FOX 603-25-150.
2. For I-temp, FOX 603-25-261.

## Thermal Characteristics

PARAMETER	SYMBOL	CONDITIONS	PKG	TYP.	UNITS	NOTES
Thermal Resistance	$\theta_{JC}$	Junction to Case	NLG32	42	°C/W	1
	$\theta_{Jb}$	Junction to Base		2.4	°C/W	1
	$\theta_{JA0}$	Junction to Air, still air		39	°C/W	1
	$\theta_{JA1}$	Junction to Air, 1 m/s air flow		33	°C/W	1
	$\theta_{JA3}$	Junction to Air, 3 m/s air flow		28	°C/W	1
	$\theta_{JA5}$	Junction to Air, 5 m/s air flow		27	°C/W	1

<sup>1</sup>ePad soldered to board

## Marking Diagrams



### Notes:

1. Line 2 is the truncated part number.
2. 'L' denotes RoHS compliant package.
3. 'I' denotes industrial temperature grade.
4. 'YYWW' is the last two digits of the year and week that the part was assembled.
5. 'COO' denotes country of origin.
6. 'LOT' is the lot number.

## Package Outline Drawings

The package outline drawings are located at the end of this document and are accessible from the Renesas website . The package information is the most current data available and is subject to change without revision of this document.

32-VFQFPN 5.0 x 5.0 x 0.9 mm Body, 0.5mm Pitch

## Ordering Information

Part / Order Number	Shipping Packaging	Package	Temperature
9FGV0441AKLF	Trays	5 x 5 mm, 0.5mm pitch 32-VFQFPN	0 to +70° C
9FGV0441AKLFT	Tape and Reel	5 x 5 mm, 0.5mm pitch 32-VFQFPN	0 to +70° C
9FGV0441AKILF	Trays	5 x 5 mm, 0.5mm pitch 32-VFQFPN	-40 to +85° C
9FGV0441AKILFT	Tape and Reel	5 x 5 mm, 0.5mm pitch 32-VFQFPN	-40 to +85° C

“LF” suffix to the part number are the Pb-Free configuration and are RoHS compliant.

“A” is the device revision designator (will not correlate with the datasheet revision).

## Revision History

Issue Date	Description
October 18, 2016	Removed IDT crystal part number.
June 22, 2017	Updated front page general description to reflect the PCIe Gen4 updates. Updated Electrical Characteristics - Filtered Phase Jitter Parameters - PCIe Common Clocked (CC) Architectures and added PCIe Gen4 data.
October 11, 2017	Corrected typographical error in slew rate specifications of differential outputs.
June 6, 2019	Changed Input Current minimum and maximum values from -200/200uA to -20/20uA.
December 1, 2025	1. Rebranded datasheet to Renesas. 2. Updated "Alternate Terminations" section. 3. Updated "Package Outline Drawings" section.

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